NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY
RESEARCH AND DEVELOPMENT DIVISION
CAMPUS STATION SOCORRO, NEW MEXICO

Status Report for Quarter Ending
30 June 1953

AIRBORNE PARTICLE STUDY

Contract N7ONR-405, Task 1
Project Designation No. NR-082-013

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by

W. D. Crozier

Submitted by

E. J. Workman

E. J. Workman, Director
30 June 1953

AIRBORNE PARTICLE STUDY

A B S T R A C T

During the quarter ending 30 June 1953 the following activities have been carried on in the Airborne Particle Study:

1. Tagging and tracing air parcels.
   - A. Preparations for tagging and tracing work in Australia in collaboration with the Commonwealth Scientific and Industrial Research Organization.
   - B. Continued organization of the 1952 results and comparison of the results with turbulent diffusion theories.
2. Work on improved instrumentation for study of ice particle persistence, to reduce the amount of impurity which may be involved in the phenomenon.
3. Another attempt to detect induced radioactivity in magnetic meteoritic spherules.
4. Continued operation of the monitor for recording natural radioactivity on airborne particles.

INTRODUCTION

This report covers briefly work done during the second quarter of 1953 under the program of Airborne Particle Study. The study comprises broadly the collection and identification of particulate matter in the atmosphere. Study of the physical and chemical properties of airborne particles is a necessary part of the program, and the work has included optical and electron microscopy, fluorescence, radioactivity, chemical work with quantities of matter down to 10^{-15}g, and nucleating properties.

Where possible, the work has included study of the bearing of results on meteorological problems. In addition to the study of particles of natural origin, considerable attention has been given to the development of techniques for tagging air parcels with appropriate artificial particles and subsequently tracing the air through meteorological processes.

Collecting equipment developed and built in the laboratory includes impaction apparatus for ground and airplane use, electrical precipitators, and thermal precipitators. Several pieces of apparatus have been built for continuous collection, enabling determination of particle abundance as a function of time.

The following persons participated in the work on the project during the quarter: W. D. Crozier, physicist and supervisor; Mary Gourley, R. J. McCarty, and M. H. Wilkening, physicists; Ben K. Seely, chemist; and Theron Young, student. R. J. McCarty and Theron Young terminated their connection with the project during the quarter.

TAGGING AND TRACING AIR PARCELS

Australian Collaboration. Negotiations were completed early in the quarter with the Commonwealth Scientific and Industrial Research Organization, Division of Radiophysics, of Australia, whereby Mr. Ben K. Seely of this laboratory is to spend several months this summer in Australia.

The Australian organization, in some of its studies of cloud physics, wishes to introduce aerosols into clouds. Since, in general, the aerosol may travel some distance before reaching the cloud, it is very desirable to have means of tracing it. The techniques developed in the Airborne Particle Study are suitable for this purpose and Mr. Seely is to assist in setting up a program for their use. The present intention is to use the same zinc sulfide pigment used in the New Mexico tests of 1951 and 1952, dispersing it together with the test aerosol, and thereby tagging the test aerosol for subsequent tracing by airplanes carrying continuously operating impactors of the type developed under the Airborne Particle Study project.

Mr. Seely left for Australia on 21 June, taking with him the "dry duster" used for dispersing pigment in the 1952 tests at Roswell, N.M., two airborne impactors, and miscellaneous equipment for preparing the collecting adhesive and coating it on impactor strips.

Some work was done in improving the feeding mechanism of the "dry duster," and a new reed-controlled d.c. driving motor was installed in one of the impactors to simplify the power supply problem and possibly to provide a greater constancy of rotation rate.

It is hoped that the Australian experiments will, in addition to assisting in tracing the experimental aerosol, provide data on turbulent diffusion to supplement the results obtained in the 1951 and 1952 tests in New Mexico.

<u>The 1952 Results</u>. Work has continued on analysis of five selected aerosol-plume cross sections explored in the 1952 tests at Roswell. It appears that the "time-mean" horizontal distribution of particles in the plumes can be fairly well expressed by an equation of the form

$$dN = Ke^{-By^n} dy$$

where dN is the number of particles found in a vertical strip of width dy at lateral distance y from the center of the plume. K and B are parameters varying with the turbulence, wind velocity and distance from the (point) source of the plume. K depends also on the strength of the source. Sutton has developed a theory in which the exponent n has the value 2, while in Calder's theory it has the value 1. Experimental study of aerosol plumes heretofore usually has been on a fairly small scale, without interference from an overlying stable layer.

In the present studies, at 4.5 to 9 mi from the source, the plumes have approached stable layers 3500 to 4500 ft above ground, and have been under the influence of irregular wind profiles. Under these circumstances it appears that n also should depend on the meteorological situation. In one case, n = 2 gave a good fit to the experimental data, but in the other four cases the values of n ranged from 1.45 to 2.84.

STUDIES OF ICE-FORMING NUCLEI

Previous Status Reports, Nos. 18 to 23, have described the discovery that submicroscopic ice particles are capable of persisting for very long times in a subsaturated atmosphere. The possibility has been recognized for some time that the presence of impurity centers in the ice particles may have a bearing on the phenomenon, and it has been suggested recently by Dr. Irving Langmuir that layers of foreign atoms on the surface of the ice particles may be involved.

In the hope of throwing light on the role of impurities, consideration is being given to performing the ice particle experiments under conditions permitting a much higher order of purity than heretofore has been attained. The requirements are a source of very high-purity air or nitrogen, an enclosure which can be freed of contamination, means for introducing very small ice particles into the enclosure, means for maintaining a known water-vapor pressure in the enclosure during a storage period, and, finally, means for detecting the residual nuclei at the end of the storage period.

Many difficulties have been encountered in designing apparatus for such experiments, and so far not all have been overcome. A number of preliminary experiments have been performed in working out details, some of which are of importance as adding to the general information previously obtained on the phenomenon. It has been possible to produce the primary ice particles in a closed glass vessel, then to store them

under subsaturation in the same vessel. Proper control of the degree of subsaturation is difficult, however, and probably will require addition of a side tube containing ice at a controlled temperature. For detection of the nuclei at the end of the storage period, it is hoped that a better means can be worked out than the simple expansion used in the earlier experiments. The use of a supercooled cloud offers advantages, and some experiments were performed in which the residual nuclei were demonstrated to be effective in nucleating ice particles in such a cloud. However, the details of introducing a supercooled cloud to the storage enclosure, or of transporting the nuclei to an external supercooled cloud, are somewhat bothersome.

STUDY OF METEORITIC PARTICLES

One additional attempt has been made to detect induced radioactivity in newly collected magnetic spherules, as described in Status Report No. 23.

The collection was made by exposing a magnet-backed paper to the atmosphere for 41 days. The magnetic collection then was transferred to the softened emulsion of an Eastman NTB nuclear plate which was then stored in a space at 30 per cent humidity for 36 days. After development the plate was searched and it was found that the collection of spherules was quite sparse. No blackening was seen that could be associated with the spherules. This fact supports the suggestion

of the previous shorter test that the induced radioactivity, if present, is of such a low level that it is not likely to be discovered by this means.

The scarcity of spherules collected in the above test, as compared with the numbers found earlier, suggests that there may be interesting fluctuations to be observed if the collecting is done continuously over a long period. Perhaps an investigation of this matter eventually may be undertaken.

RADIOACTIVITY STUDIES

Investigations of natural radioactivity of airborne particles have been confined to operation of the monitor recording such activity. This is being done particularly to collect data on the annual variations.

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